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THE PROMISE OF TECHNOLOGY[1]

By Dr. FRANK B. JEWETT

VICE-PRESIDENT OF THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY

PROGNOSTICATION, and especially long-range prognostication of technological advances, particularly those related to new sectors, is an extremely hazardous performance even in normal times. When one attempts to make prognostications for a postwar peacetime period, when one is in the midst of the turmoil of war, it is a hazardous undertaking raised to the nth power. The reason for this is because of certain very fundamental conditions affecting science and technology during a war era.

In the first place, technology is itself so vast a subject and covers such a wide range of applied science that no man in the world is wise enough at any time to predict the future except for a very short distance ahead and in very limited sectors. Even so, he can not have any great assurance of being right.

During the war period there is added to the normal uncertainties the fact that no one in the world has the slightest idea of what kind of a world we are destined to live in when the show is over. Further, no one can say with certainty when the period of active warfare will cease and the period of peace will begin. Nor can any one say with assurance what changes in science and technology will occur during the interval of active warfare still ahead of us. The present tempo of applied science to the art of human destruction and defense against that destruction is

[1] The ninth address of the second series of conferences on "Postwar Goals and Economic Reconstruction" held under the auspices of the Institute on Postwar Reconstruction of New York University. Dr. Arnold J. Zurcher, director of the institute, presented Dr. Jewett and said in part: "We have not only an engineer this evening, but we also have, I suppose, one of the most distinguished engineers in the country. In a long list of persons who have been submitted to our attention as the kind of person whom we ought to invite, Dr. Jewett stood at the head, and we are very fortunate indeed in getting him to consent to come over here this evening and talk to us." This address, together with the discussion, will become part of a volume on "Postwar Goals and Economic Reconstruction," published by the university.

exceedingly great, and quite unforeseen things are still sure to arise.

Further than that, we have not only the vaguest of ideas concerning our own internal situation, but likewise not the slightest idea of what kind of neighbors we are going to have in this world. We don't know whether the so-called peace that will follow active warfare is really peace as we like to understand it, or is to be in fact merely an armed truce during which we are permitted a breathing spell in which to prepare for a further and greater conflict. When present hostilities formally cease our mass conception of the conditions of the future will have a controlling effect not alone on our adventures in technology, but likewise on our whole national life. If we are convinced that the peace is but an armistice, many of the controls that must obtain in war but which are abhorrent in peace will be accepted and our procedures will be ordered accordingly.

Again, irrespective of whether the years ahead are to be those of a lasting peace or of an armed truce, we are not likely to be completely free masters of our own house in much that we do technologically. Even in an ostensibly peaceful world, where the competition between races and peoples and nations is a purely commercial and economic one, what others elect to do will to a large extent govern our own acting in many directions and cause us to proceed in ways and in directions which we would not choose if left to our own devices. In other words, in our present highly mechanized world what others elect to do to a large extent controls what we must do.

We know that in the past the philosophies of different nations with regard to industry generally, and to applied science in particular, have varied widely, and in many cases have been quite different from our own. Here in America for the past forty or fifty years we have lived in the shadow of a fear of the size of industries—the fear that industries might grow to such dimensions as to be beyond the control of the state. Despite this lurking fear, which has crystallized in our several anti-trust laws, industries have grown to huge proportions notwithstanding the punitive measures and the restraints we have attempted to impose. So far as the applied science industries are concerned, this anomaly is the direct result of the fact that in many cases the maximum benefits, whether in price or in quality and quantity of services to the public which are inherent in the thing to be done, can only be obtained through big units. Examples of this are legion, and the fact that it is so seems to me an indication that subconsciously and despite our professed fears we have realized that our own interests lay in pursuing the course indicated by the factors of technology.

Whether or not this is correct, the fact remains that in many directions the vast achievements of war preparation simply could not have been had, had we not built up over the years our enormous units of production and trained untold thousands of men and women in their efficient operation.

Contrasted to our expressed anti-monopoly anti-trust philosophy, many countries (and England and Germany are, I think, among them) have developed under a different philosophy. While they, no more than we, would welcome the prospect of a situation where industry dominated the state, they have not hesitated to foster the growth of great units and to trust to the ability of political government to prevent their getting out of hand. Possibly they were more far-seeing than we, but largely, I suspect, they saw the possibility of war as a background drop more clearly than we in our isolated position were able to do. The fact that the industrial and manufacturing units which grew up under these two somewhat different philosophies were larger in the United States than elsewhere is of course the direct result of our peculiar geographic situation, and because of our size our huge domestic market, our high standard of living and our urge to develop our natural resources as rapidly as possible, all made for an industrial expansion for which there was no parallel.

Any attempt at the present time therefore, except in quite narrow sectors, to make a prophecy as to what is the promise of technology in the future, with any assurance that that prophecy is a reasonable one, is quite small. In consequence, I think that what we can do most profitably this evening is to take a look at some of the fundamentals, or what seem to be fundamentals, in the science and technology sector in any postwar era.

The best way to do this, I think, is to approach the matter by taking a look at the science and technology of the prewar era; to see what they now are and what they appear likely to be when at some indefinite future date we once again lay off our uniforms.

In what I am going to say, and I suspect in the discussion afterwards, I am proposing to use the word "technology" in its very broadest aspect to include not only the things which we normally think of as technology, which are mainly the applications of the physical sciences to utilitarian ends, but also the applications of the biological sciences. This seems to me both legitimate and desirable, since such things as medicine, public health and agriculture are really technology in the sense that they are utilitarian applications of fundamental biological science.

Moreover, there is an additional reason for doing this because in looking over the wide variety of science as applied to war activities there is a marked differ-

ence in the prospective postwar utilization of war science as between the biological and physical science domains. In other words, it seems to me that the chances of direct immediate and large-scale application in a peacetime economy are greater in those things which are based on technological developments of the biological sciences for war than in those which are based on the technological developments which are concerned primarily with the creation of instruments and instrumentalities of destruction.

The reason for this feeling is that the medical technologist during a war period is dealing primarily not with attempts to destroy life but in an endeavor to prevent that destruction and to save lives endangered by wounds or disease.

In a word, the biological science technologist in war is merely continuing in a different sector, on an enlarged scale and with clinical facilities not obtainable in peacetime, more nearly the normal course of everyday life. The result is that at the conclusion of hostilities practically all that he has learned will be immediately applicable to peacetime.

Contrasted to this, the vast majority of the technological applications of the physical sciences is either directly or indirectly concerned with the destruction of human life, and much of it has no prospective peacetime application.

All that we call "technology" is nothing but the application of fundamental science discoveries and the employment of scientific methods for useful or desirable purposes. Except incidentally, technology as such is not concerned in the production of new implements of knowledge. At all times, except during periods of active warfare, the scientific and technical world is divided roughly into two main groups. First, there are those who are concerned primarily with the exploration of the unknowns of science for the purpose of extending the boundaries of knowledge, developing new facts and learning more accurately the characteristics of old ones—all this without any particular thought as to their possible ultimate utility. For the most part this group is to be found in the colleges, universities and technical schools and in the great eleemosynary foundations. Incident to this work of pioneer exploration and as an integral part of it is the training of young men and women by indoctrinating them with the established learning of the past and with the methods of science by which it has been established. This is both to produce continuously a new group of investigators for the field of fundamental science or, as has been largely the case in the last two or three decades, to train men and women for a life in industrial research.

For this group it is a well-known fact that fundamental science flourishes best in a completely free intellectual world. In other words, a sine qua non in fundamental science is that there should be complete freedom of intercourse and discussion and the publication of results, so that all may have access to them. Men make discoveries; they publish their results; they meet together for discussion and argument, and they propound hypotheses and debate them. This freedom of intercourse is not merely freedom within a given nation but is a freedom among the scientific people of the whole world. It is all based on a common desire to know the truth about the things of nature; to extend that knowledge, and a realization that each individual's aspirations are helped by common group action.

The second division is that which we commonly designate as the sector of industrial research or technology. Here to a large extent the character and training of men, together with the implements and techniques which they employ, are the same or very similar to those in the fundamental science field. The objectives, however, are different, since they are concerned not with an extension of knowledge for its own sake, but in finding ways and means for new or better applications of fundamental science to the uses of mankind.

In this second group the modus operandi under normal conditions is likewise that of free intercourse and interchange of ideas. While this was not always the case, for the last thirty or forty years technologists have used the mechanisms of publication, scientific society meetings and free discussion in practically the same way as have those in the fundamental science fields. In addition to these agencies for spreading technological information there is in this field another form of publication, namely, that of patents, in which, while the publication spreads the knowledge to all who may care to read, it spreads it with limited property rights accorded by the state.

Now what happens to these two sectors when war enters the picture? Immediately there is a radical change in the whole situation. First, intercourse between the two contending parties ceases abruptly except for a small trickle of illicit and uncertain communication. Nor is this all. Within each nation the stark necessities of secrecy imposed by war impose great barriers of confidence for fear that items of importance to the enemy may leak out. For the time being complete freedom of interchange of information in any given field is taboo. Publication is circumscribed, patents are impounded, and men, whether in the field of fundamental or applied science, have largely to work in watertight compartments with intercourse only among those in the same compartment.

The result of course is that much unnecessary duplication of work ensues, much false work is done and all work is handicapped.

Further than this, fundamental science, which is the life blood not only of an expanding store of knowledge but likewise of an expanding technology, practically ceases for the time being. It ceases both because men and women have no heart for such work, but more because the trained scientist is immediately available for effective operation in the industrial field and is therefore drawn into the whirlpool of warfare.

We are prone to talk about this war as being a physicist's war in contrast to World War I, which was designated as a chemist's war. To a large extent it is not only a physicist's and chemist's war, but likewise a biologist's war, and most certainly an engineer's war.

Because of the nature of present-day warfare and the progress of science during the past two decades, it was inevitable that the field of physical science should be the one first affected. During the past two years, in this country, all production of new fundamental knowledge in the physical science field has substantially stopped because the men and women competent to work in those fields are for the moment engaged in the more urgent work of applying their knowledge and skills in the war effort. Gradually, but possibly not quite to the same extent, the same thing is happening in the field of the biological sciences. In these fields, in addition to a deflection of objective within the field itself, we have been witness to a large translation of biological scientists into the field of the physical sciences.

In both the physical and biological science fields there has been in addition a deflection away from those who would otherwise produce new knowledge to the field of intense instruction designed speedily to acquaint young men and women with highly specialized skills required in some phase of war activity.

The result of all this is that at the end of the war we are going to find ourselves with a frontier of fundamental knowledge which is not very much enlarged from that which existed at the beginning of the war. It will be somewhat different of course because the degradation in production has not been completely uniform around the periphery, it has not been completely stopped in some sectors, it has had some accretions of an incidental character supplied by our intense endeavor to expedite war developments, and because here and there, particularly in the field of the biological sciences, the mere necessities of war have made imperative a certain amount of fundamntal science research. By and large, however, I think it is safe to say that the period of active warfare is an almost complete stagnation of progress in the field of the fundamental sciences.

Further than that, we will return to a peacetime condition with a paucity of young men and women broadly acquainted with established knowledge and rigorously trained in the methods of scientific investigation.

Against this, however, is the fact that in some sectors there has been an intense technological development, some of which will have substantial peacetime applications. Likewise, we will have a huge number of men and women who have become skilled technicians in limited fields, and above all, a population which has a quite different and enlarged understanding of science and technology. Both by reading, and more particularly by participation in the armed services or in industry, literally millions of people who would otherwise have gone through life quite unacquainted with science, except its obvious external applications, will have some real understanding of it.

This is the general outline of the picture as it appears to me, and because of my position on the National Defense Research Committee and as president of the National Academy of Sciences I presume I have about as good an opportunity as any one to obtain a general view of the whole vast field of science and technology. It is a picture of substantial stagnation in the fields of fundamental science and of a large sector of technology concerned with matters of little importance in active warfare. Likewise, it is a picture of intense activity and astounding technological results in a relatively small number of sectors, many of which results have little prospect of salvage in the postwar era.

The reason that we have made such enormous technological progress in certain directions is due to the fact, first, that we have concentrated the scientific and technical ability of the entire nation in these directions; and second, because the normal restraints of a peacetime economy do not obtain for the time being. Money is no longer a factor of controlling force. Time and success in the undertaking are the controlling essence of the job, and money as such is a very secondary consideration. Further, for the time being men and women are content to labor harder than they ever labored before and under conditions of restraint imposed by the necessities of war which they would not tolerate in normal times. For the moment every one in the field of science and technology has a single common objective which transcends in importance all other objectives, and which in addition they all desire to achieve in the shortest possible time.

Now what will happen when the armistice is signed? The minute that war is over, and particularly if the

prospective conditions of the peace are such as to indicate a long period of freedom from hostility, we are bound, I think, to see an immediate disintegration of the present machinery of science and technology. Men and women will yield to the deep-seated urge to return to their erstwhile modes of life, and in addition no one will wish longer to devote time and energy to objectives which have lost their reality. Scientific men will wish to return to life in a free intellectual world, there to pursue the quest for new knowledge. Industrial research men and technologists will hasten to take up again the things that once interested them and to expedite filling in the gaps made by the inroads of war and the forced laying aside of promising new applications of science. There will be a dearth of highly trained men for fundamental science research for general application, and a large number of men trained in specific applications. Much of what we have done during the war period will be of no peacetime value because it is concerned wholly with the things of war.

I have already mentioned the fact that the nature of this war is training millions of people to a different understanding of science and technology. Whether or not these men and women continue in some sector of fundamental or applied science, their number will be so great that their mass desire is bound to have a controlling effect on the things we do, and more particularly on the way we do them, especially in the field of technology. No one can say in advance just what this effect will be or how it will be evidenced either politically or economically.

Now I am almost through with my thirty minutes of talk. There are, however, one or two other things which I would like to lay before you as elements in the realm of uncertainty in which I think we are going to find ourselves in the beginning at least of the postwar era.

I mentioned earlier the uncertainties which would confront us of not knowing what kind of a world we are going to live in, or what the other fellow is going to do, which will force us, whether we like it or not, to do things which we might otherwise prefer not to do.

One thing which we do not and can not now know is the relation of political government to the development of technical applications of scientific knowledge. At the present time, in the midst of war, political government must of necessity control what we do and how we do it. It is the only way that a nation can wage war successfully. But coincident with the realization of this necessity we are all increasingly conscious of the limitations and deficiencies of attempting to control so vast a thing as a nation's technology in a single narrowly centralized government. It is too vast a thing to be administered effectively by any limited group having merely the clairvoyance with which God has seen fit to endow men.

On the other hand, there are certain applications of science which are of such a character that it is difficult to see how they can be carried on effectively except under some form of government support or control. If this is so, it would appear that in certain sectors at least government in the postwar era will play a bigger part in the development of science and technology than it has in the past.

An example of this is to be found in things like agriculture, where the problems are numerous and involved and where those to be benefited are a myriad of small units, each one of which can derive maximum benefit from the applications of fundamental science knowledge only through some form of cooperative effort, such as government or a government supported agency can afford.

In connection with the ultimate prospective place of political government in the field of science and technology, and in connection with a large part of current discussion about planned direction of research, there is a vast amount of popular misconception as to the role and part played by the director, whether he be a government official or an industrial research director. Any of us who have had wide experience as industrial research directors (and I have had nearly forty years of such experience) know that the director and his immediate subordinates do not direct the work of their laboratories or engineering departments in the way many people think they do. If they were wise enough to plan and direct the work in the detail which many assume, the size of the organization and character of its makeup would be drastically changed.

Actually what the director and his immediate subordinates do is to provide a proper setup in which men with creative ideas can work freely; to map out the general fields in which progress appears to lie, and finally to weigh the results of research work together with many other factors in deciding how to proceed. The real creative ideas originate hither and yon in the individual members of the staff and no one can tell in advance what they will be or where they will crop up. Every industrial research director has had the experience of having presented enthusiastically a radically new idea about the prospects of which he himself was skeptical. In such circumstances and unless the idea can be shown to be demonstrably impractical, there is only one safe thing that the director can do, namely, to afford opportunity to the originator to develop his idea, with the knowledge that if the individual is right and the director wrong good will result, and per contra, if the director is right and the

individual wrong, the latter will have satisfied himself and not have something which he thought a valuable thing discarded through an act of authority.

As an example of how impossible it is, even with simple things, to forecast the future, I have often thought of how infinitesimally small would have been the chance of any man or group of men, except the one who actually had the idea, planning to invent the common zipper.

In conclusion I should like to mention merely two or three more or less specific things which may be helpful in our later discussion as to fields where it appears that a considerable part of our war science and technology may find substantial postwar application.

I suspect that the field of aviation may be prominent in your minds. There is no question that because the airplane has shown itself to be a powerful military tool all sectors of aeronautical development have been pushed forward during the past three or four years infinitely faster than would have been the case without the impetus of war. This has been true not only as regards the airplane itself and its power plant, but likewise as regards a myriad of adjunct and incidental equipments which are needed for its safe and efficient operation. The same is true of development in those sectors of meteorology which are basically concerned with the character of the medium in which the airplane must operate.

Basically, however, the great bulk of the advances which have been made have not involved new fundamental science discoveries or even new techniques but merely a more intense utilization of existing knowledge and application of established techniques. What we have done in this field has been to concentrate a huge number of trained scientists and engineers on a relatively limited number of definite objectives and, with little or no regard for money cost, hammer out progress in the shortest possible time.

Much of what has been accomplished is with possible slight modification directly applicable to civil aviation, and many of those who have become skilled in the design, manufacture, maintenance and operation of military heavier-than-air vehicles can pass smoothly from the military to the civil sector.

Another and possibly the most spectacular of the wartime technologies is in the field of electronics. Here again, so far as I am aware, little that is fundamentally new has been produced, and yet because of the urgency of the military necessity perfectly astounding technical progress has been made. Here, as in the field of aeronautics, much of the effort has been directed to things of great importance in military operations but of minor importance in prospective civil usage. Much, however, is equally applicable. The much discussed radar devices are an illustration of this. As you know, these devices are an electrical means for detecting objects at a distance with great accuracy as to direction and distance and without regard to atmospheric conditions, such as would forestall the use of acoustical or optical phenomena. Fundamentally, radar does not involve principles which have long been recognized by science but, practically speaking, the application of such knowledge has compressed into two or three years what in normal times it might have taken a decade or two to do.

There is not the slightest reason to doubt that in the postwar era radar in various forms will serve civil needs in a multitude of ways. Collision of ships at sea in darkness, fog and rain should be a thing of the past. Likewise, collision of airplanes with mountains or structures should be uncommon rarities resulting merely from human neglect or the occasional unavoidable failure of mechanical and electrical things.

Finally, I would call your attention again to the fields of medicine and nutrition as fields in which scientific and technical progress under the mighty stimulus of war necessity will have a large direct beneficial application in the postwar era. As I pointed out, these fields, because they are concerned primarily with the saving rather than the destruction of life, have been able to develop during the war, under more nearly normal conditions of free intercourse than has been possible in the fields of the physical sciences. While some secrecy has had necessarily to be maintained in specific cases where the results were likely to have great military value, there has on the whole, I think, been a fair amount of free dissemination of progress in the biological sciences.

Added to this is the fact that war conditions present to the biological technician clinical benefits of a magnitude and kind which can not possibly be approached in normal times. Vast numbers of human beings are assembled together under the regimen of control not otherwise attainable and with opportunity for adequate clinical experimentation involving adequate control groups which not even the largest medical center can provide.

In peacetime the scientist or clinician is likely to be hampered by the desires of the subject. No such inhibition is present in a military organization.

A few new drugs may have been developed and more which had already given promise have been subjected to extensive trial and their merits or demerits largely determined. The present largely discussed penicillin is one of these, and vast preparations have been made for its quantity production from its original natural source. Even here, and in the allied field of possible synthetic production, the techniques which have been employed are not essentially the result of new knowledge but of old knowledge applied in new ways and on an enormous scale.

SCIENTIFIC RESEARCH AND THE WAR EFFORT OF U.S.S.R.

By J. G. TOLPIN

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In an exchange of letters between Professor Lena Stern, the only woman member of the Academy of Sciences of the U.S.S.R., and Sir Henry Dale, president of the Royal Society of London, which was published in *Nature* of July 17, 1943, Professor Stern declares:

> The work which is being carried on so intensively at our factories and mills, in our research institutes, in our university departments and in our war hospitals is wholly directed towards helping the front, to perfecting the arms of war, to protecting the health of our fighters.

This statement is certainly a source of encouragement, especially when the nature of some researches which Professor Stern apparently has in mind is considered. The programs of research had been conceived and begun before the actual outbreak of the present war; however, despite the fact that the Academy of Sciences of the U.S.S.R. was moved to Sverdlovsk in the Ural Mountains, and many of its institutes, laboratories and publications scattered, these programs are said to be carried out for the most part as originally scheduled. Reports indicate lively research activity going on in these institutes, as well as in the provincial divisions of the Academy of Sciences, such as the Ural Division and the Georgian Division.

S. I. Vol'fkovich, corresponding member of the Academy of Sciences of the U.S.S.R., recently published a partial roster of scientists and engineers who were awarded Stalin prizes, ranging from 25,000 to 100,000 rubles, for outstanding achievements resulting from their researches carried out in 1940 and 1941. The ruble is not quoted on exchanges outside the U.S.S.R.; the official Soviet rate of exchange is five rubles to the dollar. Although the issue of the *Bulletin of the Academy of Sciences of the U.S.S.R.* in which the article by Professor Vol'fkovich appears was published in Kazan a little less than a year ago, it did not reach this country for quite some time because of shipping difficulties.

Stalin prizes have been awarded by a special committee of the Government since 1939 for important accomplishments in the sciences, the arts, technology and the humanities. Some of the chemists mentioned in the last two lists of awards have published the results of much research in the fields of study for which they were honored, and the nature of their work is well known. Others have been engaged in research of purely military significance, and little has been published of their work. The diversity of subjects covered by the present-day chemical research in the U.S.S.R. is illustrated by the reports of the sessions of the department of chemistry of the Academy of Sciences. The February, 1942, session of this department was devoted exclusively to the research of the Radium Institute, in commemoration of the twentieth anniversary of this institute; the March, 1942, session dealt with infrared spectrum analysis and the mechanism of detonation of explosives; the May, 1942, session was partly devoted to a paper reviewing the scientific works of Professor Gilbert Newton Lewis, of the University of California, who was elected at that session an honorary member of the Academy of Sciences of the U.S.S.R.; and the July session was concerned with anodic oxidation of aluminum and its alloys. In addition, results of research on acetylene derivatives, on platinum metals and on other subjects were reported.

Ample assistance is provided by the state for every worthwhile research project. Although the number of college-trained chemists in the U.S.S.R. was estimated at the beginning of 1941 to have reached 50,000, indications were available that there were vacant positions for chemists, since the third Five-Year Plan (1938–1942) called for a greater development of the chemical industries than in any other period and was, in fact, referred to as the Chemical Five-Year Plan. The Soviet chemical industry was in a large measure created in the period between the two World Wars, and Soviet estimates show that in 1941 only 4 per cent. of the production of the chemical industry came from plants in existence before the industrialization of the country was begun.

The editors of the *Journal of Applied Chemistry of the U.S.S.R.* stated in a recent issue that on the eve of the present war (1941) there were over forty research institutes serving exclusively the chemical industry of the U.S.S.R. and seventy special colleges or college departments for training chemical engineers. These colleges had an enrolment of 35,000–40,000 students and graduated on the average 5,000 chemists and chemical engineers a year.

Many of the scientists whose work gained them distinction are well known to their colleagues abroad. Their achievements deserve, however, more general notice on the part of American scientists, and this account purports to call attention to some of these researches, particularly in the fields of chemisty and

chemical technology. The following abbreviated list shows some of the accomplishments which won Stalin prizes for the scientists responsible for them:

A. N. Bakh, president of the Mendeleev Chemical Society and director of the Biochemical Institute: Research on biochemistry; specifically, application of the results gained in the research on the action of ferments and on the chemistry of breathing to industrial biochemical processes. The results of this work were helpful in raising crops more resistant to cold and drought, improving the production of tea, baking bread, making wine, storing fruit and vegetables and drying cereals harvested before maturity. The last named is stated to be of importance for harvesting in rainy years. Perhaps it also had military significance when grain was to be harvested before time in order to prevent it from falling into the hands of the enemy.

A. E. Favorskiĭ, member of the Academy of Sciences and professor at the Leningrad University: Development of an improved method of synthesis of isoprene rubber, a result of Favorskiĭ's numerous researches on unsaturated hydrocarbons, which were published during the last fifty years. The award for this work shows the great interest the Soviet Government has in the research on rubbers other than butadiene rubber, which is the basis of the Soviet synthetic rubber industry.

N. D. Zelinskiĭ, member of the Academy of Sciences and director of the Institute of Organic Chemistry: Conversion of petroleum constituents into aromatic hydrocarbons, including toluene, and also into alcohols, aldehydes, etc.; research on catalytic cracking. Zelinskiĭ has received awards for numerous other achievements in recent years.

B. M. Rybak and co-workers, employed by the petroleum industry of U.S.S.R.: Development of improvements greatly increasing the manufacture of aviation gasoline.

B. Z. Rudoĭ, of the Institute of Mineral Fuels: Apparatus for the determination of the octane rating of motor fuels which is simpler and cheaper than the Waukesha engine.

N. N. Semenov and co-workers. Semenov is a member of the Academy of Sciences and director of the Institute of Chemical Physics: Theory of chain reactions and theory of combustion. These theories are stated to have led to methods of determining intermediate products in combustion processes and to the discovery of a number of important phenomena. The velocity of propagation of flame and inflammability limits can be predicted on the basis of the theory of combustion, and detonation can be calculated. The theory of combustion is also helpful in explaining the phenomena occurring in the combustion of fuel in internal combustion engines.

A. N. Kuznetsov, M. M. Faĭnberg and co-workers, of the Leningrad Mining Institute and the Karpov Institute of Physical Chemistry: Invention of new explosives from abundantly available raw materials, the value of which was recognized in industry and on the battle front.

I. V. Grebenshchikov, member of the Academy of Sciences and director of chemical research at the Optical Institute: Theory of the structure of glass, which describes the glass as a mesh formed by anions, with the cations being capable of more or less free motion. Application of this theory is stated to have led to the development of important borosilicate glasses of great value in optical work. It is used in almost all Soviet plants making optical war equipment.

P. P. Budnikov and co-workers. Budnikov is a member of the Academy of Sciences and professor at the Institute of Chemical Technology in Kharʹkov: Development of anhydrite cement, which is being manufactured on a large scale and is said to be an important building material.

N. P. Bogoroditskiĭ: Invention of an improved "ultraporcelain" insulating material, which is already being produced on a large scale by the radio industry.

S. I. Volʹfkovich and co-workers, of the Institute of Fertilizers and Insectofungicides: Research on processing native apatites and phosphorites providing for complete utilization of their phosphorus, calcium and fluorine. This research led to methods of production of highly valuable fertilizers, control of agricultural pests and methods of production of rare earths of the cerium group.

A. N. Frumkin, director of research at the Colloid-Electrochemical Institute and member of the Academy of Sciences: Theory of electrode processes based on research on the structure of double electrical layers; research on atom layers adsorbed on electrodes, electrokinetic behavior of metals, overvoltage and similar phenomena. This work is of importance in the understanding of corrosion, chemical sources of electrical current and industrial electrolysis.

L. I. Mandelʹshtam, member of the Academy of Sciences: Further developments in the application of Raman spectroscopy. The phenomenon of combination scattering of light was discovered by Mandelʹshtam and G. S. Landsberg simultaneously with Raman.

S. Z. Roginskiĭ, Institute of Chemical Physics. Roginskiĭ is a corresponding member of the Academy of Sciences: Theory of catalysis. Roginskiĭ established the high significance of minute quantities of impurities on the surfaces of catalysts for their specific effects.

N. S. Kurnakov and co-workers. N. S. Kurnakov was the head of the Institute of General and Inorganic Chemistry and a member of the Academy of Sciences: Physicochemical method of analysis, characterized by application of geometrical methods to the study of the relationship between composition and properties of equilibrium systems. This method, developed by the late Professor Kurnakov, led to the prognosis of rich deposits of potassium, magnesium and other salts in the Soviet Union; it also found wide application in research on and the manufacture of alloys.

G. I. Nosov and co-workers, of the Magnitogorsk Metallurgical Combine and the Research Institute 48: Development of a new type of armor steel and of a method for its production.

V. V. Mikhaĭlov and co-workers of the Ural Division of the Academy of Sciences and the Ural Metallurgical Industry: Metallurgy of carbon ferrochromium in blast furnaces.

M. N. Sobolev and co-workers: Metallurgy of ferrovanadium.

E. I. Antonovskii and co-workers, of the Balkhash Copper Combine and the Leningrad Mining Institute: Development of a successful method of producing molybdenum.

F. F. Vol'f and co-workers, of the Ural Aluminum Industry. Vol'f is professor at the Ural Industrial Institute: Development of a method of large-scale manufacture of aluminum from Ural bauxites.

P. A. Rebinder, corresponding member of the Academy of Sciences: Research on surface phenomena and the effect of small additions of active substances on the properties of solids. This work led to the development of new cutting fluids which facilitate the machining of metal. Substances were also developed as a result of these studies which reduce the hardness of geologic formations in drilling.

A. P. Belopol'skiī and co-workers, of the Institute of Fertilizers and Insectofungicides: Development of a new method of manufacture of soda and ammonium sulfate from mirabilite, resources of which are very extensive in the U.S.S.R.

G. K. Boreskov and A. G. Amelin, of the Institute of Fertilizers and Insectofungicides: Improvements in the contact method of sulfuric acid manufacture through perfection of the method of preparation of the vanadium catalyst and the refining of the gases handled.

I. N. Usyukin: Suggestion of a method of intensification of the nitric acid industry, which is stated to have high defense value.

Z. A. Rogovin and co-workers, of the Mendeleev Institute of Chemical Technology and the Institute of the Cotton Industry: Invention, now being used by industry, of a simple method of making cloth fire resistant and water repellent.

B. A. Dolgoplosk and B. A. Dogadkin: Development of a method of preparation of latex from synthetic rubber.

I. N. Nazarov, Institute of Organic Chemistry: Synthesis of vinylacetylene derivatives used by optical, machine-building, and other industries as adhesives.

A. I. Kiprianov, corresponding member of the Academy of Sciences: Invention of cyanine dyestuffs and photosensitizers.

O. Yu. Magidson, of the Chemico-Pharmaceutical Institute: Inventions in the field of pharmaceuticals, including sulfamide preparations.

A. V. Vyshnevskiī: Development of the widely used method of novocaine anesthesia and a new type of bandage.

In addition to the impetus given to chemical research by the Stalin prizes granted by the Soviet Government, the Chemical Society of the U.S.S.R. also actively encourages research. A Russian chemical journal just received contains a news account of a contest conducted by the Mendeleev Chemical Society for the best research in chemistry. The researches offered were to be judged on the basis of the following criteria: (a) importance to the war effort; (b) significance for the national economy; (c) novelty of methods used and objects of the investigation selected; (d) quality of the work carried out; (e) theoretical value of the data obtained. The day on which the researches were to be submitted was postponed from January 1 to May 1, 1943. Ten prizes, ranging from 1,000 to 5,000 rubles, and ten certificates of merit were to be awarded.

SCIENTIFIC EVENTS

PRESIDENTIAL ADDRESS AT THE ANNUAL MEETING OF THE ROYAL SOCIETY

SIR HENRY DALE, in his presidential address to the annual meeting of the Royal Society, urged that plans for the reconstruction of London should include provision for a spacious central home for the scientific societies.

There was a large gathering, and at an informal luncheon preceding the meeting the president welcomed the presence of General Smuts, a fellow of the society since 1930, and many guests, including Mr. Attlee, Sir John Anderson, Lord Woolton, R. S. Hudson, L. S. Amery, W. S. Morrison, the High Commissioner for India and the High Commissioner for New Zealand.

Reviewing the history of the society and the different quarters it had occupied, Sir Henry Dale recalled that the society remained for 50 years from its foundation a tenant of rooms in Gresham College, till in 1710, when Isaac Newton was president, it acquired the house in Crane Court, off Fleet Street, which was its home for another 68 years. In 1778 it was granted quarters in Somerset House, where the accommodation was regarded from the first as inadequate and where the society remained for nearly 80 years.

He described proposals then made for bringing the major scientific societies under one roof—the Royal, Linnean, Geological, Astronomical and Chemical Societies—centralizing and coordinating their libraries without any attempt at fusion. He said the acquisition by the Government of Burlington House, Piccadilly, provided what seemed to be the ideal opportunity of giving effect to such a plan, and the Prince Consort, with a vision of the future meaning of science far in advance of his time, privately urged the five societies to press their claim to the site.

There was much rival lobbying in those days, and a magnificent opportunity to give London a scientific

center worthy of the nation's effort was lost. The Government had already made some kind of commitment to the Royal Academy so far as the mansion of Burlington House was concerned.

In 1867 evidence came to the society, first through a statement in *The Times,* that the Government had decided to give the Royal Academy a permanent lease of Burlington House, and the right to extend northwards by building over its gardens. About the same time the large building which now fronted on Burlington Gardens was begun, and was opened by Queen Victoria in 1870.

The Royal Society began to find its present quarters inadequate as early as 1900. Its accommodation was still the same to-day. Its walls could not find room to hang the society's important collection of scientific portraits. Its great library was badly overcrowded, and it continued to grow. Library pressure, in fact, was felt to varying degrees by all the societies there, and he thought it was still true that no scheme would be able to deal with the problem efficiently, and to meet modern needs without disturbing historic associations, which did not include some kind of central coordination of libraries.

REPORT OF THE INTERNATIONAL BOARD OF INQUIRY FOR THE GREAT LAKES FISHERIES

RECOMMENDATION for joint action by the United States and Canada to restore the depleted fisheries of the Great Lakes is made in a report of the International Board of Inquiry for the Great Lakes Fisheries issued after the completion of a two-year survey and now made available to the public.

The board, consisting of two members from the United States and two from Canada, was appointed by the governments of the two countries in 1940 to study the critical situation of the Great Lakes fishing industry and to make recommendations for its preservation and development.

Although the Great Lakes are the principal source of the U. S. supply of fresh-water fish, the more valuable species are now much less abundant than formerly and some no longer support fisheries.

The Great Lakes sturgeon, source of caviar, has been commercially extinct for many years, as are several species of chubs in certain waters. Whitefish, once abundant in all the lakes, is now taken only in certain restricted areas. Lake trout, yellow perch, yellow pike perch and blue pike are among other species threatened locally.

While the total yield of the lakes—some 110,000,000 pounds annually—has not declined greatly during the past half century, less valuable species are now making up the bulk of the catch because of the decline of the choicer food fishes.

Canada's share of the Great Lakes fishery yield is some 25 to 30 million pounds or about a fourth of the total. Of the U. S. catch, about 20 per cent. is made in Lake Superior, 27 per cent. in Lake Michigan, 16 per cent. in Huron, 35 per cent. in Erie and 2 per cent. in Ontario.

During the past sixty years at least twenty-seven international or interstate conferences have been held in an effort to bring about an effective system of regulations for the fisheries of the Great Lakes. The most recent of these conferences, held in 1938, was called by the Council of State Governments and led to the establishment of the International Board of Inquiry.

In a supplement to the report of the full board the United States members, Dr. John Van Oosten, of the U. S. Fish and Wildlife Service, and Hubert R. Gallagher, of the Council of State Governments, cited as precedents for international control of a living resource the Migratory Bird Treaty, the International Fisheries Commission for the restoration of the Pacific halibut and the International Pacific Salmon Fisheries Commission. The Migratory Bird Treaty and the Halibut Commission have already achieved recognized success. The Salmon Commission, after a preliminary period of investigation, will soon undertake regulation of the sockeye salmon fishery of the Fraser River and Puget Sound.

According to the report, the majority of the U. S. fishermen of the Great Lakes favor unified control of the fisheries and are not opposed to an international treaty as a means of attaining it. A poll of fishermen conducted by the board showed that 93 per cent. favored uniform regulation and 68 per cent. expressed approval of negotiating a treaty with Canada.

THE SCIENTIFIC STUDY AND DEVELOPMENT OF PHYSICAL MEDICINE

THE first center for the scientific study and development of physical medicine as a branch of medical practice has been set up in the Graduate School of Medicine of the University of Pennsylvania under the auspices of the National Foundation for Infantile Paralysis. The foundation has made a grant of $150,000 for the five-year period from January 1, 1944, to December 31, 1948.

A statement made by Dr. Basil O'Connor, president of the foundation, reads:

> We believe this to be one of the most important steps which the National Foundation has taken. It will not only advance the treatment of infantile paralysis, but of many other diseases as well.
>
> This is but the first step in a program which should afford a scientific basis for physical therapy and lead to the establishment of a more desirable teaching program.
>
> If this branch of medicine can be given a sound professional standing, medical men of the highest caliber

will be attracted to it and practitioners will utilize fully its advantages. If research and study show there is little or no basis for treatment by some of the physical agents, then an equally great service will have been rendered, even though it be principally negative in character.

Physical medicine plays a most important part in the treatment of infantile paralysis. Since it was first organized, the National Foundation has been continuously concerned with this phase of treatment. It has spent during the past six years over $350,000 to educate and train technicians in physical therapy. An additional $364,000 has been granted to laboratories and universities to study many problems in physiology and medicine having a close connection with the practice of physical therapy, but never before has it been possible to combine in one place both medical research and teaching in this important field.

The Center for Research and Instruction in Physical Medicine will include:

A center for the development of physical medicine as a scientific part of the practice of medicine.

A training center for medical leaders and teachers in this branch of medicine.

A school for training technical workers under the guidance of such professional and scientific leadership, the school to be only incidental to and dependent upon the first two purposes.

The departments of anatomy, physiology, pathology and other basic sciences of the University of Pennsylvania will cooperate in this proposed program. The general direction will be assigned to Dr. Robin C. Buerki, dean of the Graduate School of Medicine.

LICENSING THE REPUBLICATION OF FOREIGN ORIGIN MATHEMATICAL TABLES

THE Office of Alien Property Custodian has licensed, during the past several months, the reprinting of scientific and technical books, of enemy origin, which are not available in a quantity sufficient to meet the demands of the wartime operations of science and industry.

In this connection the custodian has received several queries concerning the possibility of licensing the republication of additional Mathematical Tables. Licensed for republication and now available for purchase are Jahnke and Emde, "Funktionentafeln mit Formeln und Kurven," 1938; Jean Peters, "Siebenstellige Werte der Trigonometrischen Funktionen," 1938, and his "Achtstellige Tafel," 1939.

Before a definite decision can be made regarding the licensing of additional Mathematical Tables for republication, it is necessary for the custodian to be informed about the extent of the need of such tables and to receive suggestions of specific titles for consideration. This can be accomplished if suggestions of specific significant tables are sent by individuals to the Office of Alien Property Custodian, Washington, D. C. These suggestions or any inquiries should be addressed to the undersigned.

HOWLAND H. SARGEANT,
Chief, Division of Patent Administration
OFFICE OF ALIEN PROPERTY CUSTODIAN,
WASHINGTON, D. C.

GRANTS OF THE COMMITTEE ON RESEARCH OF THE AMERICAN MEDICAL ASSOCIATION

THE following grants have been made by the Committee on Scientific Research of the American Medical Association:

Reginald Fitz, Peter Bent Brigham Hospital, Boston, study of exophthalmic goiter.

Arthur M. Lassek, Medical College of the State of South Carolina, effect of hemiplegia on the pyramidal tract.

Warren O. Nelson, Wayne University, lipids in the adrenal cortex.

Frederick M. Allen, New York Medical College, problems of shock.

Meyer M. Harris, New York State Psychiatric Institute, muscular disease.

Deborah V. Dauber, Michael Reese Hospital, Chicago, atherosclerosis in the chick.

Wesley W. Spink, University of Minnesota, staphylococcus infection.

Roland K. Meyer, University of Wisconsin, antihormones.

Katharine M. Howell, Michael Reese Hospital, Chicago, amebic dysentery.

L. R. Cerecedo, Fordham University, vitamin B deficiencies in rats and mice.

S. A. Thompson, New York Medical College, omental grafts in the thorax.

Paul Thomas Young, University of Illinois, food preferences in the rat.

Ulrich Friedmann, Jewish Hospital of Brooklyn, tetanus toxins.

I. M. Tarlov, New York Medical College, regeneration of cauda equina.

PROFESSOR FRANK R. LILLIE AND THE MARINE BIOLOGICAL LABORATORY

THERE is printed in the *Collecting Net* the following appreciation of the services of Dr. Frank R. Lillie to the Marine Biological Laboratory at Woods Hole:

In the history of the Marine Biological Laboratory the names of two men are pre-eminent: Dr. Whitman, who with prophetic insight, envisioned this institution as a national center of research in every department of biology, and Dr. Lillie, who transformed that vision into reality. Coming to Woods Hole first in 1891 as an investigator receiving instruction, Dr. Lillie, with Dr. Whitman, organized the course in embryology in 1893. He was appointed assistant director in 1900 at a time when the fortunes of the laboratory were at a low ebb, director in 1908 and president of the corporation in 1926, after the successful conclusion of the campaign to obtain new build-

ings and an endowment. During the period from 1900 to 1942, when he resigned from the presidency, the Marine Biological Laboratory developed from a struggling organization to its present position as the leading cooperative laboratory of the world.

It is, of course, true that only by the devoted work of the members of the corporation and the active interest of its many friends, could such an end be reached; but it is equally true that without wise guidance this effort would have failed. From the beginning, when Whitman, against every force and discouragement, fought for the principles of cooperation and independence, this laboratory has pursued its steady course, adapting itself wisely to new conditions as they arose, but always holding to those basic ideals. During his fruitful years as director Dr. Lillie frequently stressed these principles. "Our purpose," he wrote, "is essentially ideal, and its pursuit demands our best efforts and our loyalty." And again, "We have laid the principle of cooperation at our foundation, and we have attempted to build it into every one of our activities." In this course he has always quietly led. There has never been any thought of division since he has been in charge. Here lies his strength, and here lies the secret of the continued success of the laboratory.

In accepting his resignation from the presidency, the corporation and the trustees are rejoiced that he will continue his connection with the laboratory as president emeritus. We extend to him and to Mrs. Lillie, who has so ably assisted him in the development of the Marine Biological Laboratory, our grateful thanks, and we pledge to him our best efforts to continue the work which he has so long and so wisely guided.

C. E. McClung
E. G. Conklin
Charles Packard

SCIENTIFIC NOTES AND NEWS

Dr. Anton J. Carlson, emeritus professor of physiology of the University of Chicago, has been elected president of the American Association for the Advancement of Science.

Dr. Arno S. Luckhardt, professor of physiology at the University of Chicago, who first used ethylene gas as an anesthetic, has received the Callahan Memorial award of the Ohio State Dental Society, "for his contribution to humanity and the healing arts."

Dr. N. G. Cholodny, professor of plant physiology in the University of Kiev, has been awarded the Charles Reid Barnes Life Membership in the American Society of Plant Physiologists. The award, made only once every five years, is given to a foreign plant physiologist. An American life membership was awarded to Dr. W. W. Thomas, of Pennsylvania State College, who is known for his work on the mineral nutrition of plants.

The Kentucky Academy of Science announces that the 1943 King Award of $50, made annually by Mr. Fain W. and Mrs. Blanche B. King, of Wickliffe, Ky., to the author of the most meritorious paper presented at the annual meeting of the academy, will go to M. J. Astle, Wendell P. Cropper and Stanly P. Stephenson for their joint papers on "Polarographic Investigation of Some Nitrocresols" and "Polarographic Investigation of Hydrogen Bonding in Nitrodihydroxybenzenes." The work was done in the department of chemistry of the University of Kentucky, and the papers were presented at the thirtieth annual meeting of the academy held on April 24 at Louisville, Ky. The award was established by Mr. and Mrs. King in 1939, to be made for five years. This marks the fifth and final presentation.

Dr. Wilmer Souder, principal physicist of the National Bureau of Standards, Washington, D. C., was elected an honorary member of the American Dental Association at the recent meeting held in Cincinnati.

At the tenth annual meeting of the American Academy of Tropical Medicine, held on November 17 in conjunction with the Southern Medical Association at Cincinnati, the presidential address, entitled "The South American Scene," was delivered by Dr. Lewis W. Hackett, assistant director of the Division of International Health of the Rockefeller Foundation. At this meeting the third Theobald Smith Gold Medal of the George Washington University was presented to Colonel Charles F. Craig, U.S.A. (retired). The following officers were elected for 1944: *President,* Colonel Edward B. Vedder, U. S. A. (retired), Oakland, Calif.; *Vice-president,* Dr. Mark F. Boyd, Tallahassee, Fla.; *Secretary,* Dr. Ernest Carroll Faust, New Orleans; *Treasurer,* Lieutenant Colonel Thomas T. Mackie, Washington, D. C.; *Councilor* (for five-year term), Brigadier General James S. Simmons, Washington, D. C. The following were elected to membership: Dr. Harold W. Brown, Dr. J. A. Curran, Dr. J. S. D'Antoni, Dr. George K. Strode and Dr. Robert Watson.

At the joint meetings of the American Pomological Society held at St. Louis, Mo., on December 13, 14 and 15, Professor T. J. Talbert, chairman of the department of horticulture and forestry of the College of Agriculture of the University of Missouri, was reelected president of the society.

At the recent meeting of the Indiana Branch of the Society of American Bacteriologists, the following

officers were elected: *President,* Dr. Norman J. Miller, Mead Johnson Company; *Vice-president,* Dr. James A. Reyniers, University of Notre Dame; *Secretary-Treasurer,* Dr. L. S. McClung, Indiana University, and *Director,* Deliah Metz, Indiana State Board of Health.

THE following officers were elected for 1944 at the annual meeting of the Board of Governors of the Institute of Medicine of Chicago: *Honorary chairman of the Board of Governors,* Dr. Ludvig Hektoen; *Chairman of the Board,* Dr. William F. Petersen; *President,* Dr. Andrew C. Ivy; *Vice-president,* Dr. Harry S. Gradle; *Secretary,* Dr. George H. Coleman, and *Treasurer,* Dr. Grant H. Laing. The newly elected members of the Board of Governors for terms of five years each are Drs. Bowman C. Crowell, Herman L. Kretschmer and Eric Oldberg.

DR. HOWARD C. TAYLOR has been appointed chairman of the department of obstetrics and gynecology of the College of Medicine of New York University. Dr. Taylor has been a member of the faculty since 1935.

HERBERT F. SCHWARZ, since 1921 associated with the American Museum of Natural History, has been appointed chairman and curator of the department of insects and spiders to succeed the late Dr. Frank E. Lutz.

BENJAMIN PARRY, first assistant to Dr. James H. Kimball, who died on December 21, has been appointed his successor as chief meteorologist of the New York Weather Bureau.

J. LOUIS NEFF, East Williston, Long Island, N. Y., has been appointed to the newly established position of executive director of the American Society for the Control of Cancer, of which Dr. Clarence C. Little is managing director.

DR. VALY MENKIN, formerly assistant professor of pathology at the Harvard Medical School, is now associate in research at the Fearing Research Laboratory of the Free Hospital for Women at Brookline, Mass. In this capacity he is continuing his studies in general pathology with particular emphasis on inflammation and cancer research.

DR. SIMON EDWARD SULKIN, instructor in bacteriology and immunology at the School of Medicine of Washington University, St. Louis, has been placed in charge of the virus research laboratory now being organized at the medical school of the Southwestern Medical Foundation, Dallas.

FIVE physicians have been appointed by President Roosevelt members of a commission to recommend possible changes in physical, mental and moral qualifications for admittance to the armed services. These are Rear Admiral Ross T. McIntire, Surgeon General of the Navy; Major General Norman Kirk, Surgeon General of the Army; Dr. Alan C. Woods, ophthalmologist-in-chief of the Johns Hopkins Hospital, Dr. Frank H. Lahey, surgeon-in-chief of the Lahey Clinic, Boston, and Dr. Edward A. Sprecker, professor of psychiatry at the University of Pennsylvania.

DR. THOMAS R. WOOD has been appointed a member of the staff of the section of organic chemistry of the Central Laboratories at Hoboken, N. J., of the General Foods Corporation.

DR. FRED OBERST, biochemist for the U. S. Public Health Service in Lexington, Ky., has recently been appointed chief of the biochemical division of the Research Laboratories of the Wm. S. Merrell Company.

THE British Minister of Production has appointed Sir Charles Hambro, chairman of the Great Western Railway, as United Kingdom member of the Combined Raw Materials Board and head of the British Raw Materials Mission in Washington. He succeeds Sir Clive Baillieu, who has held these posts since the formation of the two bodies, and had previously served as head of the British Purchasing Commission. He will return to England to become deputy-president of the Federation of British Industries.

JOHN WENDELL BAILEY, professor of biology in the University of Richmond, Va., has been granted leave of absence to enter the Army. He will serve as Major in the Specialists Corps. He left for Fort Custer, Mich., on December 26.

REAR ADMIRAL LUTHER SHELDON, JR., assistant chief of the Bureau of Medicine and Surgery, recently returned to Washington after a tour of four months to make observations of medical facilities in the United Kingdom, North Africa, Sicily, West Africa, Brazil and the West Indies. He reported, according to the *Journal* of the American Medical Association, that "existing medical facilities, and those which are now in the process of completion, will be entirely adequate to meet any contingency."

AMONG the faculty of Yenching University, Peking, recently repatriated from the North China Internment Camp, in Japanese-occupied China, were the following: Dr. Wm. H. Adolph, professor of biochemistry; Dr. Alice M. Boring, professor of biology; Dr. Martha M. Kramer, professor of nutrition; Dr. Earl O. Wilson, professor of industrial chemistry, and Dr. Stanley D. Wilson, professor of organic chemistry.

DR. KARL PAUL LINK, professor of biochemistry of the Wisconsin Agricultural Experiment Station, will deliver the fourth Harvey Society Lecture of the

current series at the New York Academy of Medicine on January 20. Dr. Link will speak on "The Anticoagulant from Spoiled Sweet Clover Hay."

DR. WALTER SYMMINGTON MACLAY, head of the Mill Hill Emergency Hospital, London, recently described the work of the Mill Hill Relocation Center to the staff and students of the Medical Branch of the University of Texas at Galveston. Army psychiatrists from camps in Texas also atended. Dr. Maclay lectured on the rehabilitation methods used and showed a motion picture of the center in operation.

AT the five hundred and forty-second regular meeting on January 6 of the Entomological Society of Washington the presidential address was delivered by Dr. R. W. Harned. The program was as follows: "Medical Entomology in Wartime," by F. C. Bishopp; "Agricultural Entomology in Wartime," by S. A. Rohwer, and "Extension Entomology," by M. P. Jones.

AS already announced in SCIENCE, the American Physical Society, the American Association of Physics Teachers and the Electron Microscope Society of America will meet at Columbia University on January 14 and 15. At this meeting there will be a joint symposium on Training Programs for Army and Navy Personnel in the Field of Physics; the retiring presidential address of President A. W. Hull, of the Physical Society; the Richtmyer Lecture and the presentation of the Oersted Medal of the Physics Teachers; thirty invited papers of the Electron Microscope Society and a number of contributed papers.

IN accordance with the recent decision of the council the next meeting of the Society of American Bacteriologists will be held on May 3, 4 and 5, at the Hotel Pennsylvania, New York City. To aid in the national transportation problem, groups which are distant from New York City will be urged to send representatives who will attend the sessions and report to their groups. The scientific program will feature contributed papers and panel discussions on wartime problems and recent research in the various fields of bacteriology and immunology. Inquiries relating to the program should be addressed to Dr. L. S. McClung, Indiana University, Bloomington, who has been appointed chairman of the program committee. Abstracts of papers contributed by members must be received on or before February 14.

THROUGH the Ophthalmologic Section of the National Research Council, at the request of Sir W. Stewart Duke-Elder; Williamson-Noble of Great Britain; Lieutenant Colonel Derrick Vail, the consulting ophthalmologist to the American Expeditionary Force, and a number of other prominent American ophthalmologists, it has been decided to produce a work of two or more volumes covering a review of the literature of ophthalmology during the war years. The first volume will cover the period starting with the beginning of the war in 1940 until January 1. The next volume will continue until the time after the cessation of hostilities when there will be a free exchange of literature. Dr. Meyer Wiener, of Coronado, Calif., will appreciate the receipt of works for review in these volumes on, or pertaining to, ophthalmology, or of interest to the ophthalmologist.

DISCUSSION

THE ORIGIN OF LANGUAGE

IT is reported that Dr. E. L. Thorndike has recently published in SCIENCE his new theory of the origin of human speech. Unfortunately, under present conditions, scientific journals from overseas are difficult to obtain in England, but it is stated that, according to the new theory, speech arose from the "babbling" of primitive men and that meanings became attached to the individual sounds by "luck"; also that the various unrelated languages of mankind were all developed in the same way.

How can this theory (if correctly reported) account for the fact that many simple sounds are found to bear closely related meanings in nearly all the language groups, or the fact that, when a single sound is found to bear many different meanings (in the same language), these various meanings are found, in many instances, to be related to one another? The relation, in this case, is that they represent different natural ways of construing the same hand- (or mouth-) gesture.

Thus, the sound (or word) *ku* is the result of a sudden release of a tongue-to-throat closure, formed far back in the mouth, and a projection of the rounded lips—so as to form an elongated tube through which the voice flows. According to the gesture theory, this mouth gesture would be related to an originating hand-gesture from which the mouth-gesture was derived by unconscious sympathy of movement between man's hands and his mouth. The originating hand-gesture, in this case, might be one in which the two slightly cupped palms were held together, pointing forward, with the balls of the two thumbs touching (so as to form a closure), and the two hands were then moved suddenly forward.

This sign and the related mouth-gesture which produces the sound *ku* (or the closely allied sounds *gu* or *hu* or *xu*—where *x* stands for the German *ch* in *ach*) might be expected to bear any of the following panto-

mimic meanings: To project (*e.g.*, as in shooting with a blow-pipe); to move or push forward—or flow or pour—or even to push *back* something in the way, or something coming towards the signer; to reach or point forward; to be elongated or extended horizontally; to enclose, a long hollow or enclosure; to be empty (*i.e.*, considering the function of the cupped hands, or the walls of the mouth cavity, as containers); to be full (*i.e.*, considering the volume enclosed by the hands or mouth as containing walls).

It will be seen that, from the sign language aspect, the same hand-gesture or mouth-gesture may be expected to bear many different meanings, and that some of these may be direct opposites!

As a test of the gesture theory, a study was made of the various underlying meanings of 37 archaic Chinese words beginning with *ku, kü, yu* and *xu*[1] and of 51 Bohemian words beginning with *ku*[2]. The results may be summarized as follows. In archaic Chinese, the various underlying meanings were found to be related to the following interpretations of the originating mouth-gestures:

Interpretation	Number of instances
To flow (as through a tube), pour out	18
To project, point towards	15
Hollow	16
Empty	8
Enclosure	9
Extended hand (or hands)—offering or receiving money	4
Tube	4
Elongated in time (antiquity)	3
Elongated hollow (*cf.* English Coombe)	3
Projecting and rounded	3
Forward motion	2
Lying flat (horizontal)	1
Repelling	1
Onomatopoeic (?)	1
Of doubtful gestural significance	6

In Bohemian the symbolism was not so imaginative as in archaic Chinese. There were no examples of the interpretations "empty," "tubular," "elongated in time" or "elongated hollow," "lying flat" or "repelling," as found in archaic Chinese. On the other hand, there were examples of all the 7 remaining types, and two cases of onomatopoeia. The numbers in parentheses refer to the number of instances. Thus, "sing (choir)" (1), eject (2) are comparable to archaic Chinese "pour" or "flow"; "project up" (3), "point" (2), "sight" (1), "bundle" (1) are comparable to "project," "point upwards." The Bohemian word for "bundle"—*kukure-se*—may be compared with Japanese *kukuri* (sheaf of corn), the *ku* gesture being reduplicated to indicate a plurality of projecting elements forming the bundle or sheaf. The remaining interpretations include "hollow" (7), "enclosure" (1), to which must be added "grasp" (1), "heap or lump" (2), "offering or taking money" (1), "projecting and rounded" (6) and "forward motion" (4). There were 9 meanings of which the gestural origin was not recognizable.

It will be seen, therefore, that over 50 per cent. of the Chinese underlying meanings of words beginning with *ku, kü, yu* and *xu* are found in connection with words beginning with the similar mouth gesture (*ku*) in Bohemian speech. Such a correlation could surely not occur if the meaning of the words were due to chance.

The gesture theory was put to the test by the late Dr. R. R. Marett, D.Sc., F.B.A., Rector of Exeter College, Oxford, in 1929, when he challenged the present writer to "divine the correct interpretation" of a number of words in an unknown language by a study of their originating mouth gestures. A list of words (with their phonetic values only) was supplied by Professor Soothill (professor of Chinese at the University of Oxford) and the first 10 of these were studied by the present writer, from the point of view of the mouth gestures which produced them. They each yielded about 10 meanings. This list of "divined interpretations" was sent to Professor Soothill, who, in return, sent his list of the principal meanings of the selected words.

The two lists were then submitted to Dr. Marett, who recorded his conclusions in a Preface which he afterwards wrote to the present writer's little book, "This English" (Kegan Paul, London, 1935). He there says: "Sir Richard Paget registered over 50 per cent. of hits that were more or less on the target, some of them undoubted bulls." Dr. Marett himself had estimated the chances of a correct interpretation, by luck, at one in the hundred.

Both Dr. Marett and Professor Soothill are now dead, but Dr. Marett informed the present writer (in October, 1942) that Professor Soothill had also been satisfied that "there was something in the method" and that he also had confirmed the success of the experiment.

R. A. S. PAGET

[1] "Analytic Dictionary of Chinese," B. Karlgren, Paris, 1923.

[2] "Slovnik Česko-Anglicý Sepsal," Karel Jonéš, Chicago, 1890.

ACTION OF CLARASE UPON PENICILLIN

IN a recent issue of SCIENCE[1] there appeared an article by the writer entitled "Sterility Test for Penicillin." Since the statement was made in a footnote that additional studies would be published on this subject, numerous inquiries have been made as to when this material would appear in print. Inasmuch

[1] SCIENCE, 98: 413, November 5, 1943.

as some time will necessarily elapse between submission of the article for publication and its appearance, the present note is intended to give preliminary information as to the mechanism of action of the Clarase and Taka-Diastase preparations upon penicillin reported previously.

Other diastatic enzyme systems than those of Clarase and Taka-Diastase used in our preliminary studies on penicillin, although derived also from the fungus, *Aspergillus oryzae,* failed completely to show evidence of antipenicillin activity. Subsequent studies revealed that the preparations active against the antibiotic agent contained, in addition to diastase or amylase, certain water-soluble, filtrable substances, which are of bacterial origin and which are responsible in part, if not entirely, for penicillin inactivation. Broth filtrates of pure cultures of many of the organisms isolated from the active enzyme preparations will neutralize the effects of penicillin. These bacteria have been identified as belonging to the gram-positive, spore-forming *B. subtilis* and related groups of organisms.

Therefore, the demonstrated power of Clarase and Taka-Diastase to inactivate penicillin in the sterility test is due to bacterial end products which these preparations contain.

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THE IDENTITY OF CLAVACIN WITH PATULIN

Waksman, Horning and Spencer[1] investigated the antibiotic agent produced by *Aspergillus clavatus* (No. 129) and proposed the name clavacin for this substance. Some time ago we began a study of the production, isolation and chemical properties of clavacin. Dr. Waksman kindly supplied one of us (H.W.A.) with *Aspergillus clavatus* (No. 129) which was grown on a Czapek-Dox medium modified as recommended by Waksman. The active material was extracted from the mold culture with ether. The ether solution was evaporated, leaving a brown gum from which the clavacin was extracted with a small volume of water. The aqueous solution was re-extracted with ether and the clavacin was obtained either by direct crystallization from the concentrated ether solution or after a preliminary purification over a silica gel column. The column was developed with moist ether which removed colored impurities first and then the clavacin. The crude material was readily purified by recrystallization from ether. The following data concerning the pure substance have been obtained: Melting point, 109–10° C; empirical formula, $C_7H_6O_4$; molecular weight (cryoscopic in benzophenone) 151, 157; $C_7H_6O_4$ requires 154); semicarbazone, darkens at 200°, decomposes at 290° C; 2,4-dinitrophenylhydrazone, darkens above 190°, decomposes about 300° C; lactone group indicated by slow reaction with alkali; saponification number 69, 71 (evidently molecule cleaved); Zereiwitinoff determination (in *n*-butyl ether) shows slightly less than one active hydrogen per mole; esterification by the acetic anhydride-pyridine method shows one hydroxyl per molecule. The substance is a neutral compound, darkens and loses activity in the presence of alkali, readily decolorizes alkaline permanganate, does not react with aqueous ferric chloride or Schiff's reagent, and is optically inactive.

At this point in our studies a publication by Raistrick and coworkers[2] appeared describing the substance patulin, an antibacterial agent produced by *Penicillium patulum* Bainier. Patulin has the same physical and chemical properties as clavacin. The 2,4-dinitrophenylhydrazones behave in the same way on heating. In order to extend the comparison the acetyl derivative and phenylhydrazone of clavacin were prepared. They melted at the same temperatures (116–117° and 151–152° C, respectively) as the corresponding derivatives of patulin. These results establish beyond question that patulin and clavacin are identical. The fact that both an *Aspergillus* and a *Penicillium* mold produce the same antibiotic substance and in about the same amount is sufficiently unusual to warrant publication of a brief note at this time. The details will be reported later.

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SCIENTIFIC BOOKS

UNDER A LUCKY STAR

Under a Lucky Star. A Lifetime of Adventure. By Roy Chapman Andrews. 300 pp. The Viking Press. New York. 1943.

The title of this book would seem to imply that fortunate circumstances were the making of Roy Chapman Andrews. But I think nearly all readers, nearly all those who know Andrews and his work will

[1] Waksman, Horning and Spencer, *Jour. Bact.*, 45: 233, 1943.

[2] Raistrick, Birkinshaw, Bracken and Michael, *Lancet,* 245: Part II, 633, 1943.

feel that the star might have shone for them in vain. The real lucky star was internal rather than external, the extraordinary character of the man, so tenacious of purpose, so skilled in carrying out his plans, so convincing to those who came in contact with him. I have a lively recollection of the occasion when he lectured at the University of Colorado. He had plenty of excellent pictures to show us, but he talked for two hours, and when he stopped I think there were few in the audience who would not have been glad to have him continue. I think it was the best popular scientific lecture I ever heard, and, lecturing as he did all over the country, he not only raised money for his next expedition, but sowed seed in the minds of thousands of listeners, seed which may yet produce a crop of scientific discoveries.

His earlier work, on whales and porpoises, tested his strength of purpose. He says:

> In thinking back over a somewhat adventurous life, my considered opinion is that nothing I have ever done required more unadulterated guts than going out on those tossing, twisting whaling vessels with the certain knowledge that I would suffer the tortures of the damned. Often I was so weak that I lay on the deck behind the harpoon gun like a dead thing and only when one of the sailors lifted me to my feet and hooked my arm about a stay could I work the camera and take my notes.

Later in life he got over susceptibility to seasickness, but this was after he had finished his work on the Cetacea.

Very interesting is his description of the Japanese in earlier times:

> My life in Japan, thirty-three years ago, might have been lived in a different country and with people of a different race, judging by the present-day Japanese. Seemingly the people I knew, and liked, have no relation whatever to the inhuman creatures we are fighting in this war of horror. . . . The everyday Japanese was a likable person, simple, full of *joie de vivre* and the worship of beauty. . . . I watched them change year by year with amazing rapidity, as they assimilated more and more Germanic ideas and *Kultur*. I saw them lose much of their courtesy and kindliness, their simplicity and charm. Each time I returned to Japan, there was less that was admirable and more of those characteristics which stamp the Japanese of to-day with the infamy of treachery and inhuman cruelty.

I can say that only twenty years ago, when in Japan, I was treated kindly and found much to admire. One may only hope that in years to come the virtues the Japanese had, they may regain, and once more contribute to the good of the world, in their own unique fashion.

The fossil-hunting expeditions to Central Asia have been so often described and illustrated in print that there is no need to review them here. But we must call attention to Andrews' plans or ideals for the future—a future he may not live to see. He believes that when the war is ended we shall see a new era of intensive exploration. Every part of the earth will be visited, but most important is Central Asia—Mongolia, southern Siberia, Chinese and Russian Turkestan and Tibet. "There is no other region on earth which will yield such important results in every branch of natural science. . . . The scientific attack must be made systematically like the campaign of an army to insure best results. It must be international."

Any one who reads the accounts of the Gobi expeditions will realize that, important as the results were, they represent only a minute fraction of what is to be found in that vast region. In the future we may expect that these regions will be opened up and, as in the case of Central Africa, will be easily reached with no great expense to the explorers. It will no longer be necessary to appeal to the millionaires, if any such survive in those days.

Andrews has written six books, but this is an autobiography, and I venture to suggest that it should be made over in several respects, to be more worthy of its theme. I should like to see it illustrated, with portraits of the author and his most distinguished colleagues, and figures of some of the more interesting fossils discovered, and of the scenery of the Gobi. I would leave out the chapters on organized vice in Japan and China, and insert an account of vertebrate paleontology in Asia, showing the work of the Andrews expeditions in relation to that of other workers, and thus bring out its importance as part of the progress of science. Thus, in the account of *Baluchitherium,* nothing is said of the gigantic skeleton which I saw (and Andrew must have seen) in the museum at Leningrad. We are told that Andrews was intimate with Dr. Davidson Black, who was "studying the remains of the 'Peking Man,' a primitive human discovered in the Western Hills." Nothing more, nothing to show that while Andrews was searching the Gobi for primitive man (where he will doubtless eventually be found), Black had obtained the very primitive *Sinanthropus* not far from Peking.

Some revision and amplification are needed. For example, we still see reported the fossil butterflies found in the Gobi. This was an excusable error made in the field, but long ago these specimens were studied, and reported on, with illustrations, in the publications of the American Museum. They are gigantic mayflies.

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MOMENTS

The Problem of Moments. By J. A. SHOHAT and J. D. TAMARKIN. xiv + 140 pp. American Mathematical Society.

THIS slim volume is the first in a series of "Mathematical Surveys," sponsored and published by the American Mathematical Society. And a good beginning it is. The authors have deftly assembled a wealth of results, mostly of somewhat specialized nature, and yet merging into general concepts.

The problem of moments, though rather special in its inception, was productive of the powerful concept of the Stieltjes integral and, in some measure, of the concept of an orthogonal system. In this respect, in the field of analysis it is second only to the problem of Fourier series which produced Cantor's set theory and Riemann's integral, and, to some extent, also Lebesgue's integral.

The authors are aware of this role of the moment problem but in outlining gentralities they are brief and to the point. They succeed in introducing the different variants of the moment problem as just so many problems in representing positive functionals on partially ordered function spaces, without mentioning the latter concept by name. Or again, they derive all pertinent facts about quasi-analytic functions as far as their problem is concerned without featuring the topic as such. However in expounding the connection with continued fractions they are emphatic in suggesting that, in substance, the problem is one of characterizing anlytic functions of a complex variable whose imaginary part is positive in a half-plane. No account of such functions is complete without reference to Hermitian operators in Hilbert space, but the authors omit the reference for lack of space. The authors' heart is obviously in "classical" analysis, and so they include a chapter on approximate quadrature instead.

This and similar books will be a good reminder to younger mathematicians that "modern" mathematics is not all abstract spaces, group theory and such like.

S. BOCHNER

SPECIAL ARTICLES

THE EFFECT OF pH ON THE AVAILABILITY OF p-AMINOBENZOIC ACID TO NEUROSPORA CRASSA[1]

SOME sulfonamides become more active as the pH is increased, this enhanced activity paralleling the ionization of the sulfonamide.[2] However, Schmelkes[3] has pointed out that sulfonamides which are so substituted as to preclude ionization also increase in activity as the pH is increased, a fact which is unexplained by the ionic theory of sulfonamide action. Since the undissociable sulfonamides supposedly do not undergo any change in the pH range involved, such an effect might be ascribed in part to decreased activity of *p*-aminobenzoic acid. The work of Brueckner[4] with *Staph. aureus* suggests that *p*-aminobenzoic acid, as well as the ionizable sulfonamides change in effectiveness as the pH is altered. But it is difficult to divorce the effect of pH on the sulfonamide from that on *p*-aminobenzoic acid in such bacterial inhibition experiments involving both of these compounds. The *Neurospora crassa* mutant of Tatum and Beadle was considered a more suitable test organism because it requires an exogenous supply of *p*-aminobenzoic acid, thus affording an opportunity to study the action of pH on the effectiveness of this substance alone.

The fungus was grown in a nutrient solution consisting of 25 g dextrose, 1 g potassium dihydrogen phosphate, 0.5 g magnesium sulfate, 2 g casein hydrolysate, 1.32 g Norit-purified fumaric acid, 0.2 ppm each of iron and zinc, 0.1 ppm manganese, 1 microgram biotin and 1,000 ml distilled water. Enough sodium hydroxide was added to adjust the pH to the various levels. Twenty-five ml of this solution was placed in 250 ml flasks, autoclaved, inoculated with a loopful of a suspension of germinating spores and incubated for 72 hours at 25° C. The mycelium was harvested, dried at 85° C. for 24 hours, and weighed.

TABLE 1

THE EFFECT OF pH ON THE GROWTH OF *Neurospora crassa* MUTANT IN THE PRESENCE OF VARIOUS AMOUNTS OF *p*-AMINOBENZOIC ACID

Micrograms of *p*-aminobenzoic acid per 25 ml of nutrient solution	The average weight in mgs of dry mycelium per flask			
	pH 4.0	pH 5.0	pH 6.0	pH 7.0
0.0	0.0	0.0	0.0	0.0
0.00625	8	..	..	..
0.0125	8	3	..	..
0.025	15	8	..	..
0.05	28	20	3	..
0.1	33	37	8	4
0.2	36	23	16	4
0.4	35	27	18	5
0.8	..	29	38	42
1.6	..	..	34	33
3.2	..	..	..	59

Table 1 gives the different treatments and the results.

The foregoing picture remained essentially the same

[1] Published with the approval of the Director of the West Virginia Agricultural Experiment Station as Scientific Paper No. 314.

[2] F. C. Schmelkes, O. Wyss, H. C. Marks, B. J. Ludwig and F. B. Strandskov, *Proc. Soc. Exp. Biol. and Med.*, 50: 145, 1942.

[3] F. C. Schmelkes, *Jour. Bact.*, 45: 67, 1943.

[4] A. H. Brueckner, *Yale Jour. Bot. and Med.*, 15: 813, 1943.

vhen the agar medium of Tatum and Beadle[5] was used nd the rate of growth was determined by measuring he diameter of the colonies. It should be stated that his fungus is variable, the amount of growth fluctu- ting over a wide range under apparently identical onditions. Nevertheless, the fundamental principle f its behavior remains the same, namely, that the ffectiveness of *p*-aminobenzoic acid as a growth actor decreases with the increase in pH.

An opposite pH effect was observed by Stokes, 'oster and Woodward[6] with a pyridoxin-requiring utant of *Neurospora sitophila.* These investigators ound that under certain conditions of nitrogen nutri- ion the fungus could synthesize pyridoxine at a rate ecessary for normal growth if the pH remained bove 6.2. However, in a medium containing no -aminobenzoic acid the pH exerted no controlling ffect on the *Neurospora crassa* mutant used in our ork. In the presence of the vitamin the fungus ttains maximum growth within a few days, whereas its absence no growth will occur during that time. his failure to grow may continue for two or three eeks, but eventually, and then within only a few days, rich growth will ensue regardless of the pH value. rom the weight of the mycelium produced in such ltures, as well as from microbiological assay of the lture filtrate, it is evident that through some adap- ve process the organism develops a latent ability to nthesize *p*-aminobenzoic acid during the prolonged cubation period. The fact that this synthesis and e growth resulting from it are not fundamentally in- uenced by the pH of the culture medium indicates at the pH effects observed in the early growth must e ascribed to changes in the effectiveness of the -aminobenzoic acid.

Since *p*-aminobenzoic acid has a dissociation con- ant of about 2×10^{-5}, at pH 4.8 it exists in solution equal amounts of molecules and ions. At pH 5.8 e molecular form decreases from 50 to 10 per cent. d above that value the portion present as the mole- le drops almost tenfold with each unit rise in pH. herefore, the efficiency of the vitamin in the nutri- on of this organism appears to be a function of the olecular form rather than of the ion.

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[5] E. L. Tatum and G. W. Beadle, *Proc. Nat. Acad. Sci.*, : 234, 1942.

[6] J. L. Stokes, J. W. Foster and C. R. Woodward, Jr., *rch. Biochem.*, 2: 235, 1943.

RAPID AND STERILIZING EFFECT OF PENICILLIN SODIUM IN EXPERIMENTAL RELAPSING FEVER INFECTIONS AND ITS INEFFECTIVENESS IN THE TREATMENT OF TRYPANOSOMIASIS (TRYPANOSOMA LEWISI) AND TOXOPLASMOSIS[1, 2]

THE following preliminary report deals with the results obtained with penicillin sodium therapy in the following experimental infections: (1) trypanosomiasis, *T. lewisi,* in laboratory rats of a Wistar strain believed to be free from *Haemobartonella muris;* (2) toxoplasmosis, and (3) relapsing fever in Swiss mice. The penicillin sodium used in these experiments was kindly furnished by Dr. Chester Keefer.

(1) *Trypanosomiasis.* Six rats weighing about 70 grams each were used in testing the therapeutic value of penicillin sodium in trypanosomiasis. Treatment was started on 4 of the rats 6 days after their inoculation with a dilute suspension of blood containing adult trypanosomes. The infections in the 2 untreated rats served as controls. The routine therapy covered a period of 48 hours and consisted of the subcutaneous injection of 2,000 Oxford units of penicillin sodium dissolved in 1 cc distilled water every 3 hours, night and day, for 2 rats, and intraperitoneal injections of the drug in a similar manner for the other 2 rats. The total dose received by each of the 4 rats was 32,000 units, or 429,000 units per kilogram. Parasite counts were made 24 hours after the initial dose and daily thereafter for 5 days. No significant difference was noted between the counts for the treated and untreated animals. All infections ran a typical course. The trypanosomes in the blood of the treated animals appeared active, unharmed, and infected other rats, producing again typical infections.

(2) *Toxoplasmosis.* In the toxoplasma experiments the mice were infected by the intraperitoneal inoculation of large doses of a strain of *Toxoplasma* highly pathogenic for mice. Sixteen mice were infected.

Treatment of lot I, consisting of 4 mice, was started the 5th day after infection; each received 9,000 units, 500 units intraperitoneally in 0.5 cc saline every 3 hours. The treatment of lot II, also consisting of 4 mice, was started on the 9th day after infection. Each mouse received 500 units intraperitoneally in 0.5 cc saline to make a total dosage ranging from 6,500 to

[1] From the Department of Comparative Pathology and Tropical Medicine, Schools of Medicine and Public Health, Harvard University.

[2] A preliminary report.

9,000 units. The treated mice died in the same interval as the infected, untreated controls.

(3) Relapsing fever ("*S. novyi*" strain). Eleven mice were inoculated intraperitoneally with 0.25 cc heparinated pooled blood from five mice showing heavy infections with *S. novyi*. Twenty-four hours later the infections were moderately heavy and treatment of six of the mice was started with penicillin sodium. The remaining 5 mice served as controls. The treated mice received intraperitoneally 1,000 units in 1 cc saline for a first dose. Every 3 hours thereafter, for 48 hours, each animal received an additional 500 units of the drug. The total dose for each treated mouse was 9,000 units. The first effects of the drug were observed 6 hours after the first dose. At this time the infections had decreased in intensity to about one fortieth in the treated mice, whereas they increased about 50 per cent. in the untreated animals. At the end of 27 hours no spirochaetes were microscopically visible in the treated mice, whereas in the untreated animals they averaged 140 in a single oil immersion field. Sixty hours after treatment was started, 2 of the apparently cured mice were sacrificed. The citrated heart blood of each mouse was inoculated intraperitoneally into two new mice. No infections resulted.

In a second experiment a relapsing fever mouse, sacrificed after receiving 4,000 units in 19 hours, was found to be a carrier, although no spirochaetes were found in a thick drop of its blood.

From the results of these preliminary experiments, it is evident that penicillin sodium, in the very large doses employed, was inactive against *Trypanosoma lewisi* and *Toxoplasma*, but was spectacularly effective in the treatment of relapsing fever.

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HEPATIC DYSFUNCTION IN MALARIA

EVERY student of the subject is aware that enlargement and tenderness of the liver and even jaundice may occur in the various forms of malaria. Nevertheless, relatively little attention has been given to the possibility that hepatic dysfunction and its associated derangements in metabolism can exist in this disease. Slatineau and Sibi,[1] and Phocas[2] did note that some degree of transitory hepatic insufficiency exists in nearly all cases, but their data has not received general acceptance. More recently Kopp and Solomon[3] studied the influence of induced tertian malaria on the liver function of nine patients under treatment for general paresis. They noted a transient disturbance in liver function which usually cleared up within three to six weeks after the termination of the malaria.

With the increasing incidence of malaria consequent to the war, it became important to establish further the probability that an associated liver dysfunction is more frequent than is generally acknowledged. Towards this end, the status of the function of the liver was studied in a series of malaria patients by means of various tests and constituents of the blood. The present preliminary report deals with two cases without a previous history of malaria before the present attack, six with recurrent malaria and a history dating back as long as six months to two years, and two patients with a definite history but no evidence of malaria at the time of study.

The preliminary pertinent data obtained at various intervals during the patients' hospitalization are summarized in Table 1 and reveal that every patient with malaria had an abnormal cephalin cholesterol flocculation test. The majority of the patients also demonstrated an increased sedimentation rate, an anemia, a high serum globulin and, in fewer instances, a slightly increased icteric index. For purposes of comparison another flocculation test, the Kahn test for syphilis, was performed at the same time as the cephalin cholesterol flocculation test. In every instance a negative result was obtained.

Many studies with the cephalin cholesterol test have established that this procedure is an excellent, sensitive measure of hepatic damage. The data summarized previously, therefore, may be interpreted as indicating that in nearly every case of malaria some degree of liver damage may exist. Since the initial test was performed in several instances before any therapy was instituted, it is probable that neither atabrine nor quinine are factors in the production of the hepatic damage.

The presence of liver damage in malaria necessitates revision of modern treatment, since not only is it necessary to administer the specific drugs aimed at the elimination of the plasmodia, but it is necessary also to institute measures which may result in a restitution of the liver to normal. Such measures are the administration of high carbohydrate, high protein, high vitamin diets and not the administration of "only fluids during the course of the fever," as is advocated by some of the leading students of malaria.

The efficacy of a diet aimed at improving the status of the liver is suggested by the fact that patients thus treated may show a rapid disappearance of the positive cephalin cholesterol flocculation test, while patients not treated in this manner show a positive floc-

[1] A. Slatineau and M. Sibi, *Arch. Roumanes de Path. Exper. et Microbiol.*, 7: 529, 1934.

[2] E. Phocas, *Rev. Med. et Hygiene Tropicales*, 29: 246, 1937.

[3] I. Kopp and H. C. Solomon, *Am. Jour. Med. Sci.*, 205: 90, 1943.

TABLE 1
HEPATIC FUNCTION IN MALARIA

ame	Plasmodium	History	R B C	Reticulocytes	Sedimentation rate	Total cholesterol	Blood sugar	Icterus index	Serum albumin	Serum globulin	Kahn	Bromsulfalein	Cephalin-cholesterol
			M/cmm	/100	mm/hr	mgm/100	mgm/100		gm/100	gm/100		%/45 min	
L	Falciparum	Acute	2.66	..	8.1	...	...	18	5.5	1.5	Neg.	..	+++
A	0	Chronic (?)	3.70	..	31.5	195	69	6	..	..	Neg.	0	++
B	Vivax	Acute	3.80	0.5	51	110	111	11	4.0	3.0	Neg.	0	++++
L	0	Chronic (?)	4.30	0.1	14	280	88	5	3.7	2.5	Neg.	..	++
W	Vivax	Recurrent	4.11	..	...	230	79	18	4.0	2.0	Neg.	..	++
H	Falciparum	"	4.33	0.5	...	225	...	10	4.5	2.2	Neg.	..	+++
McC	Vivax	"	3.77	1.4	...	155	...	11	4.5	2.9	Neg.	..	++++
S	0	"	4.17	0.4	29	205	91	5	4.9	3.1	Neg.	0	++
R	Vivax	"	4.4	1.9	30	120	64	4	4.0	3.3	Neg.	12	++++
ER	Vivax	"	4.7	0.9	10	190	101	9	4.3	2.9	Neg.	0	+++

lation reaction as long as one year after the last tack.

Further and more extensive studies as to the status the liver in malaria are imperative. It may be important also, to determine the relationship of liver mage to the incidence of recurrences and the development of immunity. Such studies will form the basis a more complete report.

CONCLUSIONS

(1) The cephalin cholesterol flocculation test was sitive in all ten cases of malaria of varying duration. This is interpreted as indicative of the presence hepatic damage.

(2) It is proposed that in addition to the specific drugs, a high carbohydrate, high protein and high vitamin diet be administered early in the therapeutic régime.

Major Mirsky is indebted to Dr. David Klein, The Wilson Company, Chicago, Ill., for generous supplies of the cephalin-cholesterol mixture.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

PENICILLIN ASSAY

Outline of Four-Hour Turbidimetric Method

THE following method of determining the potency penicillin solutions is advantageous in that it is veniently set up and makes possible the turbidiric reading of the test in the same test-tubes in ich the culture is grown. In these respects it is eved to be more practical than turbidimetric meth- proposed by others.[1]

Procedure: Into a duplicate series of nine sterile, gged and standardized test-tubes (18 × 140 mm) e aseptically, in order, the amounts of sterile Veal-cose Broth[2] noted in column 4 of Table 1. These

TABLE 1

Units of penicillin (standard)	Penicillin Sol. added: Strength	cc	Amount of broth in tubes	Optical density: Standard No. 1	No. 2	Unknown
None	..	..	9.6	.33	.32	.30
0.05	0.5 per cc	0.1	9.5	.30	.29	.29
0.10	"	0.2	9.4	.27	.26	.26
0.15	"	0.3	9.3	.22	.22	.23
0.20	"	0.4	9.2	.19	.20	.21
0.25	"	0.5	9.1	.17	.18	.19
0.30	"	0.6	9.0	.15	.15	.17
0.35	"	0.7	8.9	.15	.15	.16
0.35	"	0.7	9.3	.00	.00	.00

[1] J. W. Foster, *Jour. Biol. Chem.*, 144: 285, 1942; J. W. ter and H. B. Woodruff, *Jour. Bact.*, 46: 196, 1943; W. Foster and B. L. Wilker, *Jour. Bact.*, 46: 387, 1943.

[2] Veal-Glucose Broth: 1. To 500 gm ground veal from kling calves 6–8 weeks old, which have not been ghtered more than one week, add 1,000 cc of distilled r and soak overnight, in refrigerator. 2. Boil 15 tes, strain through cheesecloth and make up to origi- volume of water. 3. Sterilize at 15 pounds pressure for 45 minutes. For convenience, a quantity of this base-infusion can be made at one time and stored. 4. Filter sterile veal infusion prepared as above through wet, coarse filter paper. 5. Add Bacteriological Peptone (P.D. & Co.), 1 per cent.; Sodium Chloride (Diamond Crystal), 0.5 per cent.; Dextrose C.P., 0.1 per cent. 6. Heat to dissolve. 7. Adjust to final pH of 8.0 (8.6 at this point). 8. Heat at flowing steam for 15 minutes. 9. Filter through wet fine paper. 10. Fill as desired. 11. Sterilize at 15 pounds pressure for 20 minutes.

are for the standard which is run in duplicate. For each unknown solution to be assayed, prepare one additional row of nine tubes.

Prepare a solution containing 0.5 unit per cc of the penicillin standard in cold sterile distilled water and add to the broth tubes according to the amounts in column 3. From estimated values of units for the unknown samples, prepare a solution of each which contains an estimated 0.5 unit per cc. Add these solutions to their respective rows of tubes in the same manner as the standard. Place into each tube (except for the last which serves as a colorimetric and sterility control) 0.4 cc of an 18–20 hour culture of *Staphylococcus aureus* (National Institute of Health No. 209). The culture is prepared by inoculating a flask containing Veal-Glucose Broth from an agar slant. This resulting suspension, which is used as the inoculum, should have an optical density of about 0.4.

Place the tubes into an incubator or constant temperature water-bath at 37° C for 4 hours or until the optical density of the control tube reaches about 0.30 (0.27 to 0.34 has been found to be satisfactory). (A constant temperature water-bath has been found to give more consistent results and hence a smoother curve). At the end of the growing period immerse the tubes in cold water (about 10° C or less) to stop active growth of bacteria. After cooling, the tubes should be wiped dry and shaken thoroughly.

Measure the density of each tube by means of a photoelectric colorimeter[3] using a red filter. These values are recorded opposite their corresponding tubes, as may be seen in Table 1, a typical protocol.

[3] Lumetron. Manufactured by Photovolt Corp., New York City.

The densities are plotted as the ordinates against penicillin units as the abscissae. A smooth curve is drawn through these points. This is done for each row of tubes representing the standard, thus giving two curves which correspond to the duplicate standard. A line is then drawn halfway between these two curves and serves as the average curve which is employed in the calculation of the number of units in the samples of unknown strengths. This calculation is explained in Table 2.

TABLE 2

A Units of penicillin in standard	Optical density of unknown	B Units of unknown (read from curve)	C Estimated units of unknown	Units of unknown $\frac{B}{A}$ C =
0.05	0.29	0.056	5000	5600*
0.10	0.26	0.096	"	4800
0.15	0.23	0.136	"	4500
0.20	0.21	0.168	"	4200
0.25	0.19	0.210	"	4200
0.30	0.17	0.260	"	4330
0.35	0.16	0.290	"	4150
				Av. = 4370

* Not used in calculation because 5600 is definitely out of range.

Values obtained by this method are characteristically in good agreement. Consecutive assays on two samples were 48300, 47600, 45300, 49400 and 1675, 1516, 1300, 1580, respectively. In five consecutive days the units per cc of one standard as calculated from the curve of its duplicate were 0.495; 0.52; 0.45; 0.52 and 0.49, respectively.

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